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(54) Abrasive Composition

(57) An abrasive composition comprises a co-fused mixture of bauxite and zirconia which has been rapidly solidified and comminuted, the composition containing from 25 to 50 weight percent zirconia, from 49.2 to 74.2 weight percent alumina and from

0.8 to 2.5 weight percent silica. The method of manufacture comprises fusing a mixture of bauxite and zirconia, cooling the fused mixture to solidify the composition within three minutes of the time that cooling to solidify the composition is commenced and comminuting the resulting cooled mixture to form abrasive particles.

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SPECIFICATION

Bauxite-Zirconia Abrasive and Products Containing Same

- The present invention relates to bauxite-zirconia abrasive grain and more particularly relates to such grains which contain from about 25 to about 50, and preferably from about 35 to about 50 weight percent zirconia. The invention further relates to coated and bonded abrasive products incorporating such grains. 5
- Alumina (aluminium oxide) is and has been used as the primary abrasive material for a long time. Alumina has enjoyed such use due to a combination of ready availability, toughness and hardness. While other harder substances, such as diamond, are known, which have been used as highly effective abrasives, until recently no commercially competitive substance has been available having overall abrasive properties superior to those of alumina. 10
- Attempts have been made to alloy alumina with other oxides such as zirconia (zirconium oxide) to obtain an abrasive having properties superior to alumina. Such attempts have met with some success when at least about 10% zirconia is fused with aluminium oxide and when the fused zirconia-alumina mixture is rapidly solidified. 15
- U.S. Patent 3,156,545 to Kistler et al discloses that an abrasive having a grinding removal rate comparable to the removal rate of alumina can be prepared by rapidly cooling a composition containing alumina, zirconia and a substantial amount, i.e. about 15% to about 60% by volume, of glass, such as silicon dioxide, to form a glassy matrix, in which particles of zirconia and alumina are embedded. The resulting abrasive on the average, was not, however, substantially superior to alumina in steel removal rate. 20
- Other alumina-zirconia alloys have, however, been disclosed in subsequent U.S. Patents wherein high purity alumina and zirconia are used. The products disclosed in the subsequent patents do show substantial improvement in performance by the disclosed alumina-zirconia abrasives when compared with alumina. 25
- For example, U.S. Patent 3,181,939 to Marshall and Roschuk discloses that high strength abrasives can be obtained when from about 20 to about 60% weight percent zirconia is fused with alpha alumina and the resulting fusion is rapidly cooled. U.S. Patent 3,181,939 discloses that such abrasives are suitable for steel snagging operations where high strength is required. The patent, however, requires that the alpha alumina be of high purity, usually at least 99.8% by weight aluminum oxide, and further indicates that the purity of the zirconia should be preferably at least about 99%. 30
- As disclosed in U.S. Patent 3,891,408 to Rowse et al and U.S. Patent 3,893,826 to Quinan et al, the best grinding and polishing abrasive characteristics are obtained when the proportions of zirconia to alumina are such that a eutectic structure is formed when the fused alumina-zirconia mixture is rapidly cooled. The Quinan et al and Rowse et al Patents similarly teach that high purity alumina and zirconia should be used. 35
- It has now been discovered that, despite the teachings of U.S. Patents 3,181,939; 3,891,408; and 3,893,826; highly effective alumina-zirconia abrasives can be prepared using readily available impure materials such as bauxite as the source of alumina and baddeleyite as the source of zirconia. It has in fact now been unexpectedly found that alumina-zirconia abrasives can be prepared from impure starting materials which in at least some respects are superior to the abrasives prepared from pure alumina and zirconia starting materials. Furthermore, in accordance with the present invention, contrary to the teachings of Rowse et al, it has been found that at least 0.8 and preferably at least 1.1% silica should be intentionally incorporated into or retained in the abrasive composition. The percentage of silica should not, however, exceed about 3 weight percent of the composition. 40 45
- Therefore, in accordance with the invention, there is provided an abrasive composition comprising particles of a co-fused mixture including zirconia, bauxite and silica, if necessary, which has been solidified from an essentially homogeneous molten state within about three minutes and preferably within one minute from the time that initial cooling to solidify the composition is commenced. The finished abrasive composition contains from about 25 to about 50 and preferably from about 35 to about 50 weight percent of zirconia; from about 49.2 to about 74.2 and preferably about 49.2 to about 64.2 weight percent alumina; and from about 0.8 to about 2.5 and preferably from about 1.1 to about 2.4 weight percent silica. 50
- The invention further comprises the method of manufacturing the novel abrasive composition and coated and bonded abrasive articles incorporating the novel abrasive composition. 55
- The abrasive composition in accordance with the invention is a composition comprising particles of co-fused bauxite and zirconia. The particle size of the abrasive composition may be from 6 to 900 grit as defined by the U.S. Department of Commerce commercial standard CS 271-65, issued April 12, 1965. The grit size is preferably between about 6 and about 180 and most desirably is between about 14 and about 80. 60
- The bauxite and zirconia are fused, i.e. melted together, to form a co-fused mixture of bauxite and zirconia. Sufficient bauxite and zirconia, are preferably used to obtain from about 49.2 to about 64.2 weight percent alumina; from about 35 to about 50 weight percent zirconia and desirably from about 0.8 to about 2.5 weight percent silica in the co-fused mixture after solidification. The preferred

solidified composition contains from about 40 to about 45 weight percent zirconia; from about 1.1 to 2.4 weight percent silica and from about 50.5 to about 58.9 weight percent alumina. Desirably, the composition also contains up to about 2.5 weight percent titania (titanium dioxide) and preferably contains from about 0.25 to about 2 weight percent titania. The most preferred composition contains
 5 from about 0.25 to about 1.6 weight percent titania. The silica content in the most preferred composition is from about 1.3 to about 2.0 weight percent silica.

The abrasive composition in accordance with the invention is prepared using unpurified calcined bauxite or only partially purified bauxite, i.e. alumina made by the fusion and reduction of calcined bauxite with metallic iron and carbon. When unpurified calcined bauxite is used directly, iron and
 10 carbon should be incorporated into the bauxite-zirconia fusion to remove iron oxide and some but not all silica and titania. "Bauxite", as used herein includes unpurified calcined bauxite, partially purified bauxite, or synthetic bauxite. Bauxite is the preferred alumina source since it requires less refining than pure alumina and usually contains sufficient silica and titania to provide the silica and titania requirements of the composition in accordance with the invention. Bauxite used by the abrasive
 15 industry usually contains from about 3 to about 4.5 weight percent titania, from about 3 to about 8 weight percent silica and from about 3 to about 10 weight percent iron oxide (Fe_2O_3).

The bauxite which is used may be synthetically produced, i.e. the bauxite which is used may be formed by combining pure alumina with desirable impurities such as silica and titania to obtain a composition which can be substituted for naturally occurring bauxite.

20 From about 0.1 to about 0.5 weight percent of particulate carbon is usually incorporated into the blend prior to fusion when partially purified bauxite is used. More carbon, i.e. from about 2 to about 5 weight percent is added, with from about 5 to about 10 weight percent metallic iron, when unpurified calcined bauxite is used. The percentages of carbon and iron added are dependent upon the quantity of iron oxide, silica and titania impurities on the bauxite. The appropriate quantities of iron and carbon to
 25 be added can be readily calculated by those skilled in the art. Any particulate carbon is suitable and petroleum coke is frequently used. During the fusion and carbon reduction process, if metallic iron is present, excess titanium, silicon and iron separates from the fusion and is removed. After fusion, using partially purified or unpurified bauxite as described above, the mixture usually contains the desired quantity of silica and titania. Iron in the form of oxide or alloy may remain in the fused mixture in very
 30 low percentages, i.e. about 1.5 weight percent or less.

Should the bauxite fail to provide sufficient silica or titania to meet the required silica and titania content in the preferred composition, additional silica or titania can be added to the fusion.

The zirconia is preferably provided in the form of baddeleyite ore which usually contains from about 95 to about 99 weight percent zirconia, from about 0.3 to about 3 weight percent silica, from
 35 about 0.5 to about 2 weight percent titania and from about 0.5 to about 2 weight percent iron oxide.

When compared with bauxite, the baddeleyite ore is found to contain lower percentages of silica, titania and iron oxide impurities than unpurified bauxite. "Zirconia" as used herein includes baddeleyite ore, zirconia bubbles made by smelting of zircon ore, and purified zirconia.

The only impurities which may occur in the finished abrasive composition which are believed to
 40 be somewhat detrimental in excessive quantities, are alkali and alkaline earth oxides such as calcium oxide, magnesium oxide and sodium oxide (soda). Even these impurities do not, however, seem to detrimentally affect the abrasive composition when their combined percentage is less than 1 weight percent. The combined weight percent of these impurities, in the preferred embodiment, is however, less than about 0.5 weight percent. In practice, the resulting abrasive composition manufactured by
 45 co-fusing bauxite and baddeleyite ores usually in fact contains less than about 0.5 weight percent of combined calcium oxide (CaO), magnesium oxide (MgO), and soda (Na_2O).

The melted (fused) mixture is solidified within about three minutes and preferably within one minute from the time that initial cooling to solidify the composition is commenced. "Initial Cooling" as
 50 used herein means the time at which any portion of the melted mixture becomes permanently solidified due to its exposure to a temperature below the solidification temperature of the mixture. The solidification temperature of an alumina-zirconia eutectic mixture, i.e. a mixture containing about 42 weight percent zirconia and about 58 weight percent alumina, is about 1700°C and is somewhat higher when greater percentages of alumina or zirconia are present.

To obtain the best results, solidification time, i.e. time for complete solidification, should be within
 55 about 1 minute and more preferably within about 20 seconds of the time that initial cooling to solidify the composition is commenced.

Any suitable method for rapidly cooling the melted mixture may be used to quickly solidify the mixture. For example, the mixture may be poured upon a bed comprising 4.5 cm diameter or smaller steel balls. The ball size is preferably about 2 cms in diameter. The mixture may also be rapidly cooled
 60 by pouring upon very small lumps of solidified composition, i.e. about 0.7 cm in diameter or smaller or may be rapidly cooled by casting in thin sheets, i.e. about 2 cm thick or smaller, upon the surface of a steel plate. It is believed that any cooling method may be used wherein the melted composition is cast or poured upon a heat sink having a high heat conductivity, i.e. in excess of about 0.05 calories per second per square centimeter per cm per degree C at about 1200°C and wherein the maximum
 65 distance through the cast or poured material to the nearest heat sink surface is less than about 2 and

preferably less than about 0.5 cm. Heat sink materials, such as lumps of previously solidified composition, which have lower conductivities may be used provided that the thickness of the cast or poured melted composition is substantially smaller, e.g. in the case of lumps of previously solidified material, less than about 0.7 and preferably about 0.3 cm.

Desirable heat sink materials not only have high heat conductivity, but have reasonably high melting temperatures. Steel is a preferred heat sink material for these reasons and because of its lower cost and availability. An example of another commercially feasible heat sink material is cast iron. Examples of other possible good heat sink materials, which are not used primarily due to their cost, are: chromium, nickel, zirconium and their alloys. High heat capacity of the heat sink material is also desirable.

After solidification, the resulting composition is comminuted to the desired grain size. Such comminuting is usually accomplished by jaw crushing followed by compact crushing or roll crushing.

In accordance with the method for manufacturing the particulate abrasive composition, a thoroughly blended mixture of particles comprising from about 35 to about 50 weight percent zirconia, and from about 50 to about 65 weight percent bauxite is fused. The particle size of the zirconia and bauxite and other ingredients which are blended are not particularly critical and may range from as large as five centimeters to as small as a micron provided that all components are of approximately the same particle size. The most desirable particle size is between about 200 mesh and one centimeter. The mixture preferably contains sufficient silica to obtain from about 0.8 to about 2.5 weight percent silica in the composition after solidification. The silica in the mixture is usually provided by the bauxite or by baddeleyite which also provides the zirconia. The mixture of particles is obtained by blending particles of bauxite and zirconia usually in the form of baddeleyite. The alumina and zirconia containing particles may also be simultaneously blended with particles containing silica and titania if additional silica and titania is desired. Usually no additional silica or titania is required but between about 1.1 and about 2.5 percent silica and up to 2.5 weight percent titania by combined weight of bauxite and zirconia may be blended into the composition provided that the silica and titania in the finished abrasive composition do not exceed three weight percent each and preferably do not exceed two weight percent each. Blends of bauxite with up to 50 weight percent purified alumina particles can also be used as the source of alumina.

After blending, the particle blend is fused, usually at a temperature above about 1800°C. After fusion, the mixture is cooled to solidify the fused mixture within about three minutes and preferably within one minute of the time that initial cooling to solidify the mixture is commenced. The time to solidify the fused mixture is most desirably less than about 20 seconds. After the mixture is cooled and solidified, it is comminuted to form the particulate abrasive composition. The comminuting of the solidified mixture is usually accomplished by jaw crushing followed by impact crushing or roll crushing as previously mentioned.

The zirconia in the resulting abrasive has been found to be between about 10 and 25% in the tetragonal crystal phase and the average size of the primary alumina and zirconia crystals, if any, is over 60 microns in length. The diameter of the primary crystals is between about 30 and about 60 microns. The spacing of the zirconia eutectic phase particles is usually between 2500 Å and 5000 Å.

The particulate abrasive composition of the invention can be utilized to form novel coated and bonded abrasive products. While such products are not superior in performance to prior art alumina-zirconia abrasives in all applications, they do have superior characteristics in at least some applications. The bonded abrasive products in accordance with the present invention include such products as grinding wheels. To form such bonded abrasives, the novel particulate abrasive is bound together by a suitable resin, particularly phenolic type resins such as phenolformaldehyde, resorcinolaldehyde, cresol-aldehyde and amine-aldehyde resins such as urea aldehyde and melamine formaldehyde resins. The resulting bonded abrasive articles have grinding characteristics superior to alumina and comparable to, though not necessarily superior to, prior art alumina and zirconia grain manufactured from essentially pure alumina and zirconia.

Coated abrasive articles comprising the novel abrasive of the invention adhesively bonded to a flexible backing, have grinding characteristics which, in at least belt grinding applications, are superior to any known prior art alumina or alumina-zirconia coated abrasive article. The superior performance is particularly unexpected since the present grain intentionally contains at least 0.8% weight percent and preferably at least 1.1% weight percent silica whereas prior art grain such as that disclosed in U.S. Patent 3,891,408 to Rowse and Watson preferably contains less than about 0.3% and essentially below 1% silica, and was preferably manufactured from purified materials such as purified alumina.

The backing utilized in forming the coated abrasive in accordance with the invention, can be any suitable backing such as paper, woven cotton or polyester cloth or fiber mat. In accordance with the present invention, the backing and adhesive, especially when the coated abrasive is an abrasive belt, should be durable since it has been unexpectedly found that the novel abrasive may actually have a longer useful cutting life than the useful life of backing material or adhesive. The adhesive which binds the abrasive to the flexible backing should be a heat curable resin such as a phenolformaldehyde resin.

It has also been unexpectedly found that even further improvements in abrasive characteristics in bonded products can be obtained when the abrasive grain of the invention is blended with up to 60

weight percent and preferably from about 5 to about 60 weight percent of another abrasive grain such as alumina or partially purified bauxite.

The following examples serve to illustrate but not limit the present invention. Unless otherwise indicated, all parts and percentages are by weight.

5 Example I

49.8 weight percent of partially purified particulate bauxite comprising about 1.2 weight percent silicon dioxide and 2.9 weight percent titanium dioxide; 49.8 weight percent of particulate zirconia bubbles comprising about 10.5 weight percent alumina, about 3.5 weight percent silicon dioxide and about 0.9 weight percent titania; and about 0.4 weight percent of calcined petroleum coke are mixed in a Patterson-Kelly Twin Shell Dry V-blender for 10 minutes.

About 39 Kg of the resulting mixture is fused in a 17 inch diameter, 14 inch deep 150 kw single phase double electrode furnace. The resulting fused mixture is poured into a mold filled with about $\frac{3}{4}$ inch diameter steel balls. The mold is about 50 cms in diameter and about 15 cms deep.

The crude abrasive i.e. solidified melt, is hand separated from the steel balls on an inclined table which permits the balls to roll away from the crude.

The crude is crushed in a 18 inch by 10 inch Economy Allis Chalmers roll crusher. The crude is passed through the crusher four times and each time the gap is reduced by a ratio of between 2:1 and 3:1 per pass. After four passes the abrasive grits are screened. Oversize grits are returned to the crusher.

The grit is then further treated by three passes through a Pennsylvania Hammer Mill at 900 rpm and the resulting grits are graded.

The abrasive grits are found to contain about 1.4 weight percent silicon dioxide, about 1.6 weight percent titanium dioxide, about 43 weight percent zirconium dioxide and about 0.5 weight percent other impurities. The balance of the abrasive composition is aluminium oxide.

25 Example II

The procedure of Example I is followed except essentially pure tabular alumina is substituted for the bauxite and only about 0.1 weight percent of petroleum coke is added since very little silica or iron is present. The resulting abrasive grain contains 0.24 weight percent silica.

Example III

The procedure of Example I is followed with the following exceptions: A much larger furnace and a mold about seven feet in diameter by seven feet high is used. Unpurified calcined bauxite is used with metallic iron and carbon. No zirconia is used and no steel balls are used in the mold. No impact crushing is used. The result is a brown alumina abrasive grain.

Example IV

The procedure of Example III is followed except the abrasive is subjected to impact crushing to increase its bulk density.

Example V

Each of the grains prepared in Examples I, II, and III are used in making abrasive belts and are tested as follows:

A double coated abrasive material is made by electrostatic coating a 36 grit test grain over a coating of 36 grit conventional brown aluminium oxide grain prepared in accordance with Example III which is deposited by gravity on the finished cloth.

The fabric selected for the backing material is a heat set, 4/1 sateen weave polyester, approximately 103x40 threads per square inch, cloth finished in a conventional manner, with a finished weight of approximately 30 lbs per ream. (Sandpaper ream: 480 9x11 sheets).

A maker adhesive mix consisting of a commercial one stage, liquid phenolic resin with a formaldehyde-phenol ratio of approximately 1:1 and ground limestone with an average particle size of between 17 and 25 microns is made using a 1:1 wet weight mix proportion.

The maker mix is then heated to 90°F and coated on the backing using a standard roll coating method. Approximately 20 lbs per ream of adhesive is applied.

Using conventional sandpaper making equipment, the fused alumina abrasive of Example III is then gravity coated with approximately 30 lbs per ream of grain applied. Immediately following the gravity coating, the test grain is electrostatically projected on the wet web with approximately 34 lbs per ream being retained.

The abrasive adhesive coated backing is then heated to 175°F for one hour and 200°F for two hours in a maker rack. After drying, a size coat is applied by standard roll coating methods with between 25 and 29 lbs per ream being applied. The size mix consists of the same 1:1 phenolic resin-filler ratio previously used. However, a non-buffered synthetic cryolite with an average particle size of 25 microns is used as the filler instead of limestone. Drying and curing is then accomplished by heating the coated material for one hour at 150°F, five hours at 175°F and 16 hours at 225°F.

After curing the material is edge trimmed and flexed perpendicular to the edge to offer ease of handling for belt making. Abrasive belts (2 inches x 132 inches) are manufactured from the coated abrasive material according to usual techniques. These are then evaluated on a conventional heavy duty floor backstand belt tester using ASI 1018 cold rolled steel as a workpiece. In this test, the belt is placed on the backstand in the standard manner and a 1 x 1 x 36 inch workpiece is positioned so that it engages the belt on the one inch square side just below the horizontal diameter of the contact wheel.

The abrasive belt in the test is driven at 4200 surface feet per minute (SFPM) over a contact wheel 14 inches in diameter. 63 lbs of dead weight in-feed force is exerted on the workpiece. Testing is for 30 seconds after which stock removed from the bar is measured (weight before grind—weight after grind) and recorded. This sequence is continued until the measured stock removed is 20 grams or less per grinding interval. Total stock removed in this manner for the test belt is compared to total stock removed for the other test belts as shown in Table I.

Table I

	<i>Grain Tested</i>	<i>Stock Removed</i>	
15	Example I (bauxite-zirconia)	3834 grams	15
	Example II (alumina-zirconia)	1934 grams	
	Example III (bauxite)	850 grams	

This test clearly shows the superior stock removal of the grain of the invention in belt grinding.

Example VI

A mold cavity for forming a 6 inch by 2 inch by 5/8 inch cup wheel is filled with a blended composition comprising 83 weight percent of grain manufactured in accordance with Example IV; having a grain size distribution of 50 weight percent of 14 grit, 25 weight percent of 16 grit, and 25 weight percent of 20 grit; 2.9 weight percent of RCI Varcum® 8121 liquid phenolic resin having 72 to 76% resin solids, a viscosity of from about 325 to 405 cps, and a gel time of from about 32 to 38 minutes at 121°C; 4.55 weight percent of RCI Varcum® 7608 powdered phenolic resin having a softening point of from 80 to 90°C, a hot plate cure at 150°C of 45 to 55 seconds, an inclined plate flow at 125°C of 26 to 34 mm and a hexamethylene tetramine (hexa) content of 8.6 to 9.2 weight percent; 4.55 weight percent of Borden AD6096 polyvinyl butyral modified powdered phenolic resin having a melting point of 105 to 108°C, an inclined plate flow of 125°C of 12 to 17 mm and a hexa content of 6.1 to 7.2 weight percent; and 5.0 weight percent powdered fluorspar.

The composition is molded at a sufficient pressure to obtain a density of 2.74 grams/cc and is then cured at a temperature of about 180°C for 9 hours.

Example VII

The procedure of Example VI is followed except that the abrasive of Example IV is substituted by a mixture consisting of 50 weight percent of 14 grit abrasive prepared in accordance with Example I, 25 weight percent of 16 grit abrasive prepared in accordance with Example I and 25 weight percent of 20 grit abrasive prepared in accordance with Example I.

Example VIII

The procedure of Example VI is followed except that the abrasive of Example IV is substituted by a mixture consisting of 50 weight percent of 14 grit abrasive prepared in accordance with Example I, 25 weight percent of 16 grit abrasive prepared in accordance with Example I and 25 weight percent of 20 grit abrasive prepared in accordance with Example IV.

Example IX

The wheels prepared in accordance with Examples VI, VII and VIII are tested for performance by running them on a model CP3490 Chicago pneumatic air grinder at a wheel speed of 6000 rpm using an air pressure of 90 to 100 psi. The grinder is hand held for 30 minutes in a position which allows the wheel to grind a cast steel block.

The wheel and block are both weighed at the start and finish of the 30 minute test period to determine the total abrasive consumed. The results are given in Table II.

Table II

<i>Wheel Tested</i>	<i>Metal Removed per Minute</i>	<i>G. Ratio Gms Metal/GMS Wheel</i>
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50	Example VI (alumina)	16.3 grams	8.7	50
55	Example VII (bauxite-zirconia)	27.9 grams	10.9	55
	Example VIII (bauxite-zirconia and alumina blend)	27.9 grams	13.4	

This Example shows that the abrasive of the invention is superior to alumina in grinding rate in the wheels tested and can unexpectedly be combined with alumina to obtain longer wheel life without sacrificing grinding performance.

Claims

- 5 1. An abrasive composition comprising particles of a co-fused mixture, including bauxite and zirconia, which has been solidified from an essentially homogenous molten state within about three minutes from the time that initial cooling to solidify the composition is commenced, said composition containing from about 25 to about 50 weight percent of zirconia; from about 49.2 to about 74.2 weight percent alumina and from about 0.8 to about 2.5 weight percent silica. 5
- 10 2. An abrasive composition as claimed in Claim 1, wherein said composition contains from about 35 to about 50 weight percent zirconia and from about 49.2 to about 64.2 weight percent alumina. 10
3. An abrasive composition as claimed in Claim 2, wherein said composition contains from about 1.1 to about 2.5 weight percent silica.
- 15 4. An abrasive composition as claimed in any one of Claims 1 to 3, wherein said solidification from the molten state occurs within about 1 minute from the time that initial cooling to solidify said composition is commenced. 15
5. An abrasive composition as claimed in Claim 4, wherein said solidification from the molten state occurs within about 20 seconds from the time that initial cooling to solidify said composition is commenced.
- 20 6. An abrasive composition as claimed in any one of Claims 1 to 5, wherein said composition contains from 1.1 to about 2.5 weight percent silica. 20
7. An abrasive composition as claimed in any one of Claims 1 to 6, wherein said composition contains up to about 2.5 weight percent titania.
- 25 8. An abrasive composition as claimed in Claim 7, wherein said composition contains from about 0.25 to about 2 weight percent titania. 25
9. An abrasive composition as claimed in Claim 8, wherein said composition contains from about 0.25 to about 1.6 weight percent titania.
10. An abrasive composition as claimed in any one of Claims 7 to 9, wherein said composition contains from about 40 to about 45 weight percent zirconia.
- 30 11. An abrasive composition as claimed in Claim 10, wherein said composition contains from about 1.3 to about 2.0 weight percent silica. 30
12. An abrasive composition as claimed in any one of Claims 1 to 11, wherein at least a portion of said silica is provided by the bauxite.
- 35 13. An abrasive composition as claimed in any one of Claims 7 to 9, wherein at least a portion of said silica and titania is provided by the bauxite. 35
14. A method for manufacturing a particulate abrasive composition which comprises:
 - a) fusing a thoroughly blended mixture of particles, said mixture comprising from about 35 to about 50 weight percent of zirconia, and from about 50 to about 65 weight percent of bauxite;
 - 40 b) cooling said fused mixture to solidify said fused mixture within about three minutes of the time that initial cooling to solidify said mixture is commenced, and; 40
 - c) comminuting the resulting cooled mixture to form abrasive particles.
- 45 15. A method as claimed in Claim 14, wherein from about 1.1 to about 2.5 weight percent silica by combined weight of bauxite and zirconia is blended into the mixture prior to fusion. 45
16. A method as claimed in Claim 14 or 15, wherein said fused mixture is solidified within about one minute of the time that said cooling to solidify is commenced.
17. A method as claimed in Claim 16, wherein said fused mixture is solidified within about twenty seconds of the time that said cooling to solidify is commenced.
- 50 18. A method as claimed in any one of Claims 14 to 17, wherein from about 0.1 to about 0.5 weight percent of particulate carbon is blended into the composition prior to fusion. 50
19. A coated abrasive article comprising the abrasive composition of any one of Claims 1 to 13, adhesively bonded to a flexible backing.
20. A bonded abrasive article comprising the abrasive composition of any one of Claims 1 to 13 adhesively bound together.
- 55 21. A grinding wheel comprising the abrasive composition of any one of Claims 1 to 13 adhesively bound together in a wheel shape. 55
22. A bonded abrasive article comprising an adhesively bound blend of the abrasive composition of any one of Claims 1 to 13 with up to about 60 weight percent of alumina.
- 60 23. An abrasive composition substantially as hereinbefore described. 60
24. A method of manufacturing a particulate abrasive composition substantially as hereinbefore described.

- 25. A bonded abrasive article substantially as hereinbefore described.
- 26. A coated abrasive article substantially as hereinbefore described.
- 27. A grinding wheel substantially as hereinbefore described.

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